Space Weather Technical Forecast

Issued on Tuesday, 04 July 2023 at 13:02 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Active fluence declining. R1/R2 Radio Blackouts likely. G1/Minor Storm to G2/Moderate Storm possible on 06 July with CME arrival.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low, with occasional C-class flares. There are currently six sunspot regions on the visible disc. AR3354 in the northwest remains the largest and most complex region. This region is becoming more difficult to analyse as it continues to rotate closer to the northwest limb, and the current classification will be maintained as it rotates off. AR3359 in the southeast maintains a slightly complex magnetic structure. AR3360 in the northeast has continued to show minor growth and has a partially north-south aligned magnetic structure, perhaps increasing instability. The remaining regions on the disc are relatively small or simple.
A recent CME has emerged in coronagraph imagery, likely associated with a filament disruption near AR3359. This is still under analysis, but looks likely to have an Earth directed component, which may arrive during 06 July.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by ACE at L1, has been at mostly ambient levels. Wind speeds have varied between 340-420 km/s. The density has been below average. The IMF was weak throughout, at 7 nT or below, while the north-south component varied weakly. The phi angle was positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, was at mainly high levels, peaking at 3083pfu at 03/1515 UTC. The 24-hour integrated fluence has been on a slight rising trend just above the Active threshold throughout. A fluence of 1.45e8 was recorded at 04/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate activity is likely, with a slight chance of further X-class flares. The risk is mostly coming from AR3354 in the northwest, and reduces as this region rotates off.

Solar Wind / Geomagnetic Activity: A CME from a filament disruption near AR3359 on 04 July is still under assessment, but appears to have an Earth directed component. This currently seems most likely to arrive later on 06 July. Solar wind speeds are currently at ambient levels. Any enhancements during 04 July from CH20/- are expected to be weak. A further HSS from CH22/+ is likely either on day 4 (07 July) or after the end of this period on 08 July, with solar winds increasing to between 500-600km/s.
Geomagnetic activity is expected to be mostly Quiet to Unsettled at first, increasing to Active to G1/Minor Storm with any CME arrival, with a chance of G2/Moderate Storm and a slight chance of G3/Strong Storm activity. As the CME effects wane, Unsettled to Active conditions may be prolonged by any HSS later in the period, with a chance of G1/Minor Storm intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight but declining chance of reaching the S1/Minor Storm threshold throughout the period. The

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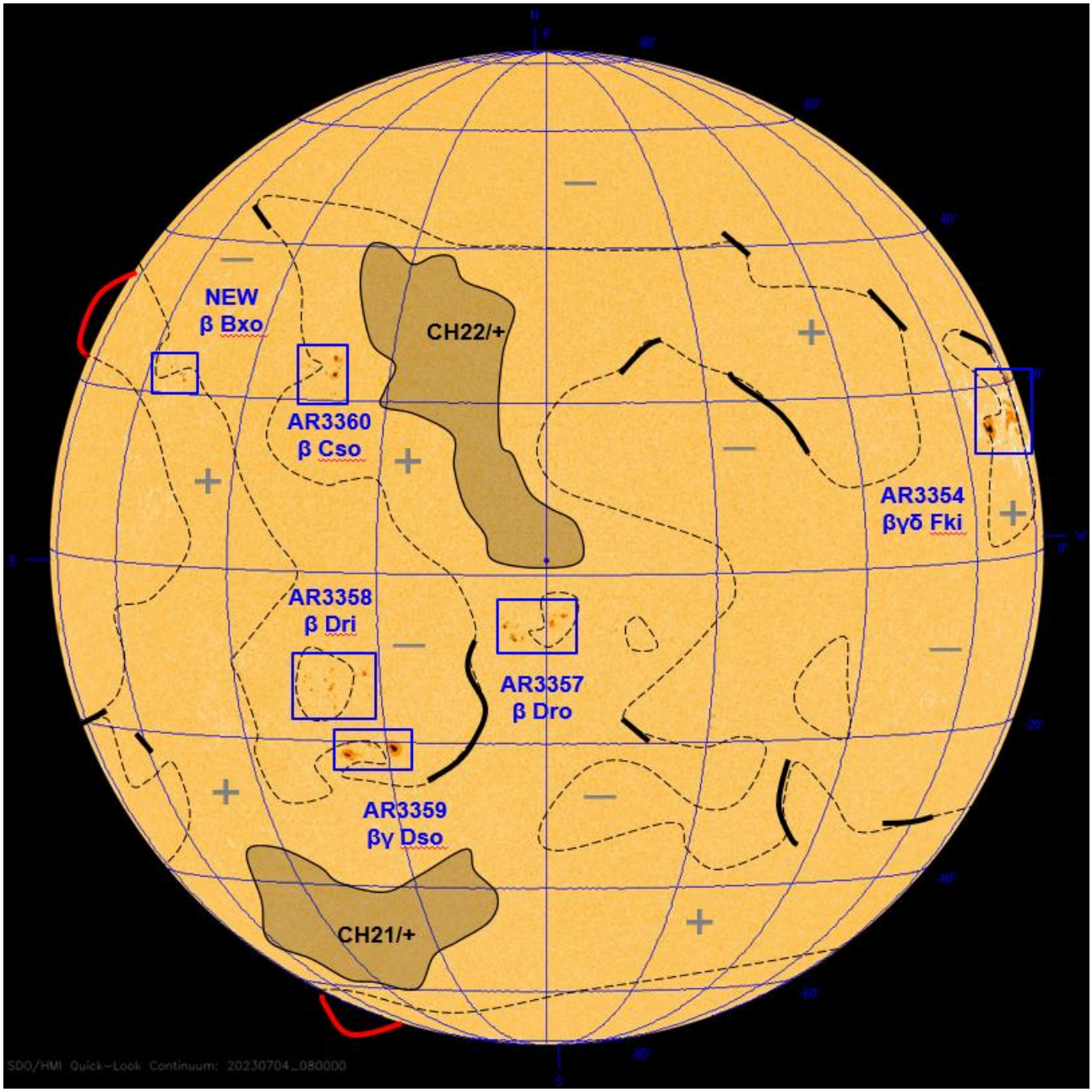
risk reduces as AR3354 rotates away from the limb. High energy electron flux (greater than 2MeV) is expected to slowly decline, with a sharper drop likely as the CME arrives on 06 July. The corresponding fluence is above the Active (1e8 integrated flux) threshold and is also expected to drop more rapidly with the CME arrival.

Figure 1. Solar Analysis Valid 04/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME associated with the M3.8 flare from AR3354 on 29 Jun is now thought to have missed Earth. A further CME from a filament disruption near AR3359 on 04 July is still under assessment, but appears to have an Earth directed component. This currently seems most likely to arrive later on 06 July.

Solar wind speeds are currently at ambient levels. A connection to small CH20/- in the southwest may occur later on 04 July into the 05 July, however any enhancements from this are expected to be weak. A further HSS from CH22/+ is likely either on day 4 (07 July) or after the end of this period on 08 July, with solar winds increasing to between 500-600km/s. Geomagnetic activity is expected to be mostly Quiet to Unsettled at first, increasing to Active to G1/Minor Storm with any CME arrival, with a chance of G2/Moderate Storm and a slight chance of G3/Strong Storm activity. As the CME effects wane, Unsettled to Active conditions may be prolonged by any HSS later in the period, with a chance of G1/Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	50	30
Strong	G3	No	1	1	10	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/0900	Partial	AR3359	SE	750 km/s	06/1800 UTC	Bulk of ejecta passing below Earth, but CME arrival likely

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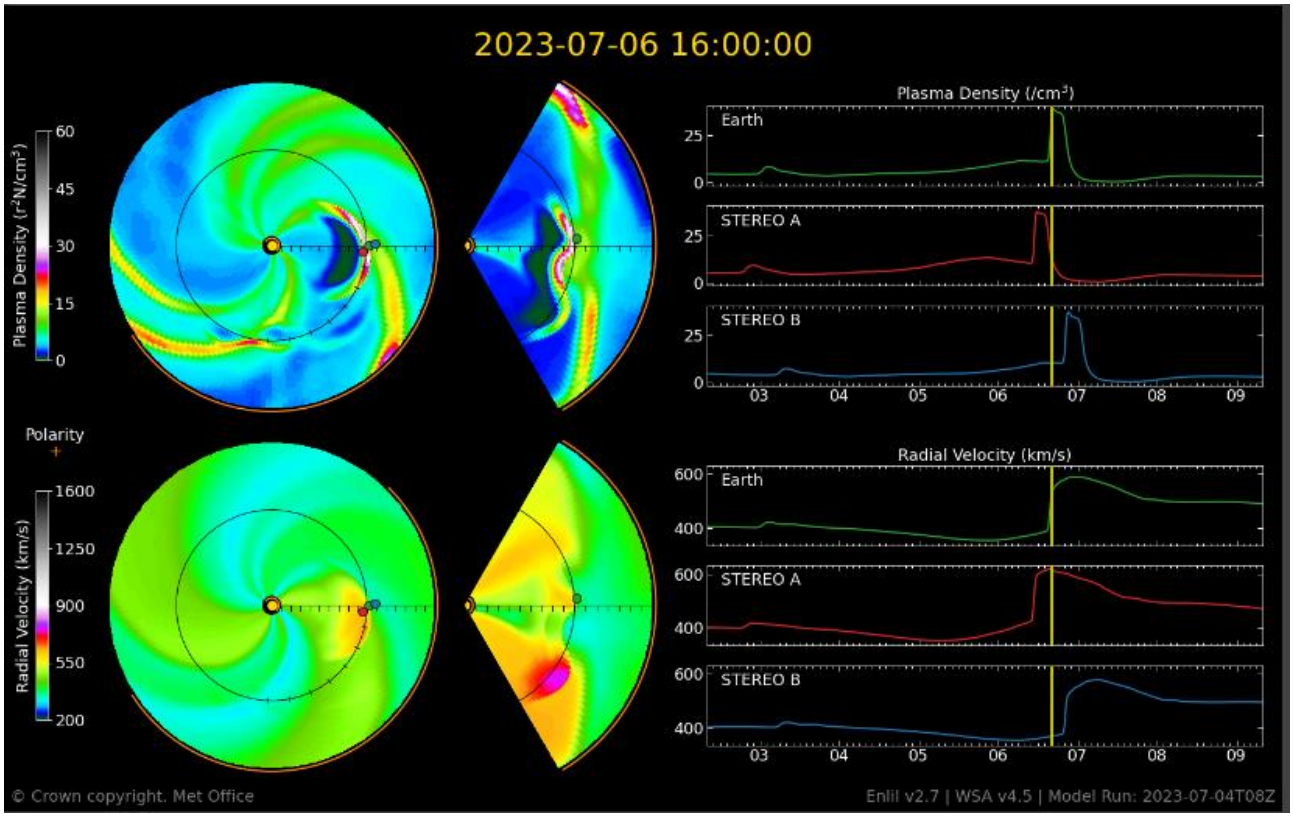
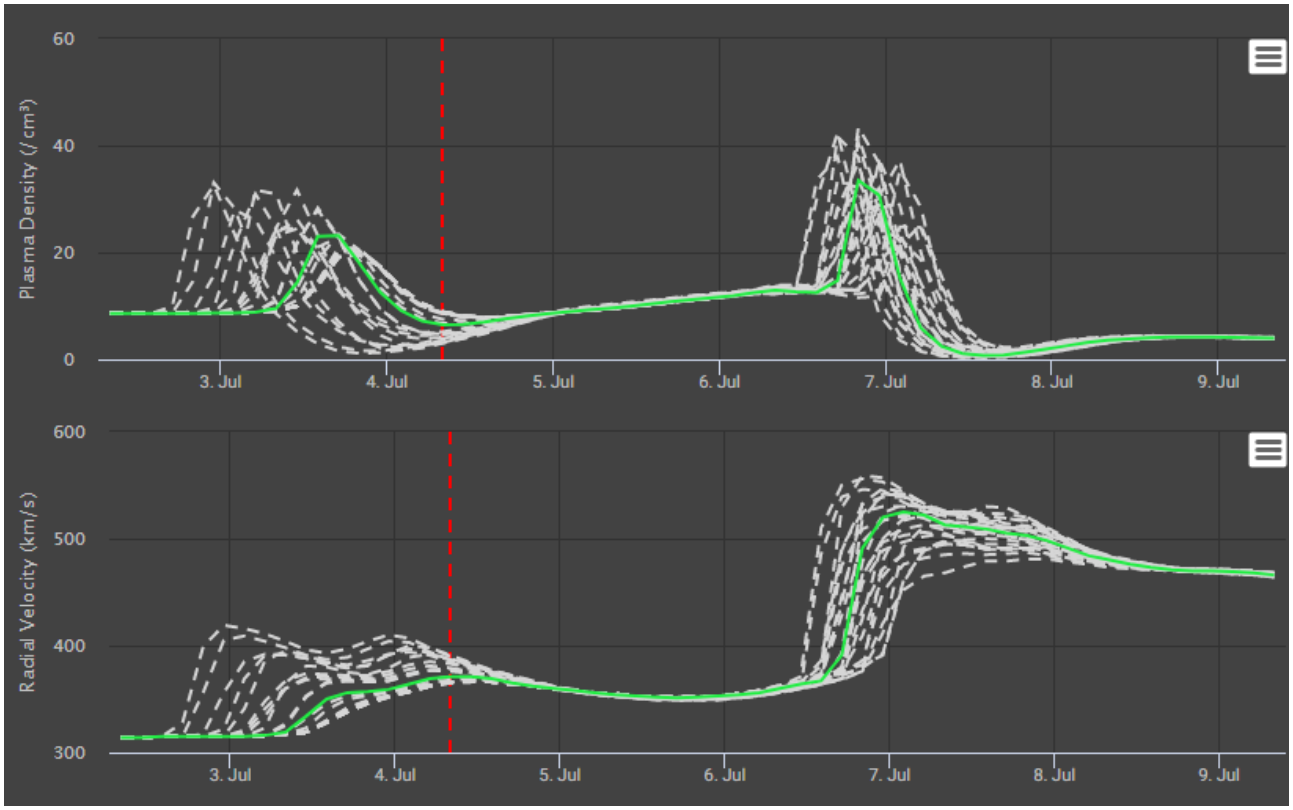
Figure 2: MOSWOC Enlil and ensemble showing CME arrival likely on 06 July.





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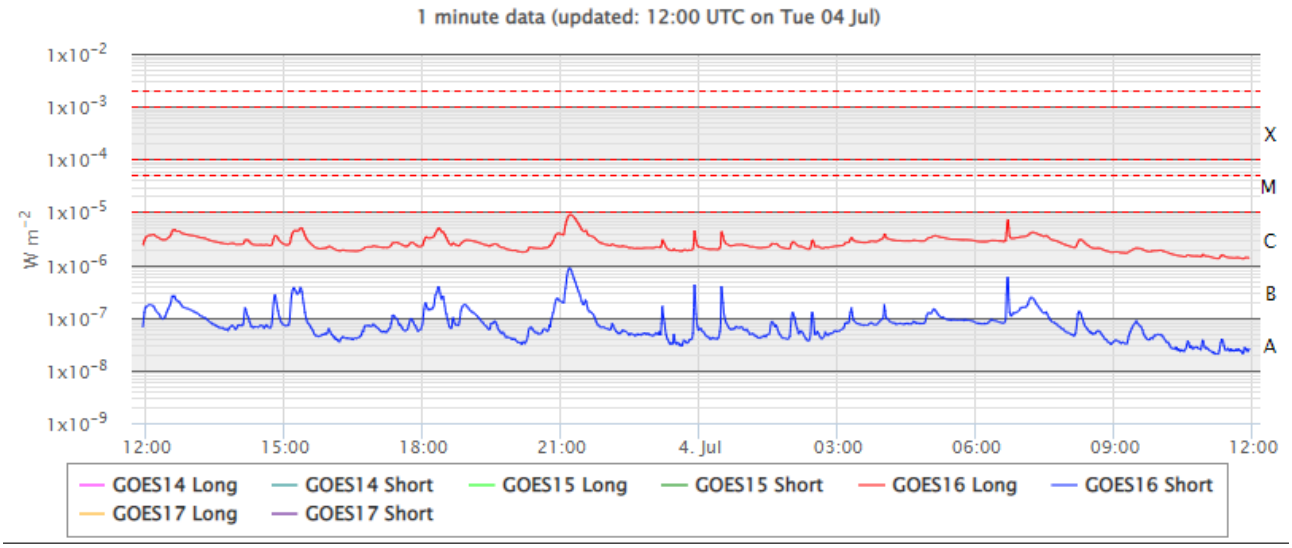
Radio Blackouts - X-Ray Flares:
Solar activity has been Low over the last 24 hours, with occasional C-class flares.

There are currently six sunspot regions on the visible disc. AR3354 in the northwest remains the largest and most complex region. This region is becoming more difficult to analyse as it continues to rotate closer to the northwest limb, and the current classification (Fki/Beta-Gamma-Delta) will be maintained as it rotates off. AR3359 in the southeast maintains a slightly complex magnetic structure. AR3358, which is close to AR3359, is showing signs of decay. AR3360 in the northeast has continued to show minor growth and has a partially north-south aligned magnetic structure, perhaps increasing instability. The remaining regions on the disc are relatively small or simple.

Low to Moderate solar activity is expected with a slight chance of further isolated X-class flares, most likely from AR3354. However, this region rotates off the disc during 05 July, leading to a declining risk of flares during 05-06 July. As such the flare risk reduces during the period, but this may be revised should additional sunspots develop or active regions emerge over the east limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	50	40	30
Very Active	R3 to R5 X Class	No	15	10	10	5

Figure 3: X-ray flares in the last 24 hours at C-class levels



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. There is a slight but declining chance of S1/Minor storm levels being reached through this period. This is mainly due to AR3354, given its favourable location in the western hemisphere. The risk from this region is now reduced back to previous levels, as there have been no effects seen from the X1 flare on 02 July. Although AR3354 rotates off during 05 July, the risk of radiation storms remains until it is well over the limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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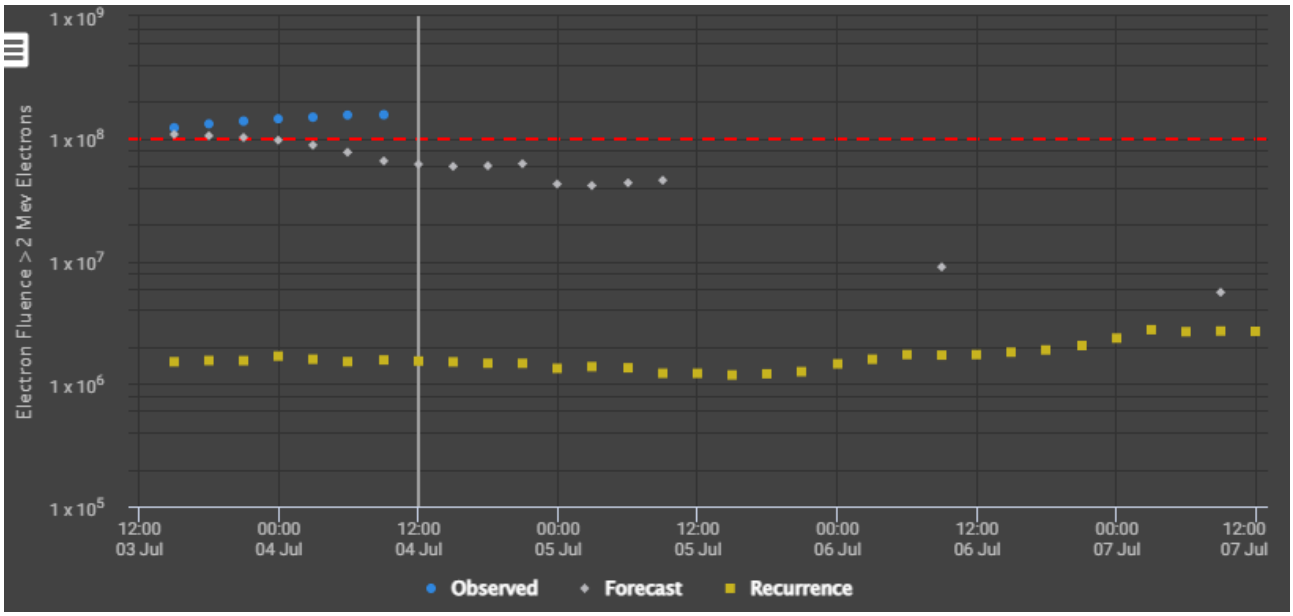
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been reaching mostly high levels of late. It is likely to continue this pattern at first, although it is likely that there will be a gradual decline in flux levels at GEO through the period. A recent CME is now becoming apparent, which may arrive at Earth during 06 July. This is likely to cause a sharp drop off in flux levels at GEO.

Electron fluence will start above the Active threshold (>1e8 integrated pfu), probably with a slow decline at first, although confidence is low in the exact timing of any decrease below Active. A sharper decline is then likely later in the period with the likely CME arrival. MOSWOC REFM is also suggesting a decline below Active, which is a reasonable trend in the short term, although it won't be taking account of the anticipated CME.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	50	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: MOSWOC REFM showing a decline in fluence below Active, although it isn't taking account of the likely CME arrival.



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